

WHAT IS CLAIMED IS:

1 1. A method for monitoring transmissions over a unidirectional optical fiber loop
2 coupling multiple nodes, characterized by:
3 measuring a round trip delay time for a signal sent from a first node to travel around the
4 unidirectional optical fiber loop and be received at the first node, and
5 using the measured round trip delay time to account for temperature induced affects on
6 signal transmissions over the unidirectional optical fiber loop.

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8 2. The method in claim 1, further comprising:
9 measuring a first round trip delay time;
10 subsequently measuring a second round trip delay time;
11 determining a temperature-induced delay time correction based on the first and second
12 round trip delay times; and
13 determining a time difference between the first node and one or more other nodes
14 coupled to the unidirectional optical fiber loop based on the determined temperature-induced
15 delay time correction.

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17 3. The method in claim 2, further comprising:
18 time synchronizing the multiple nodes taking into account the determined temperature-
19 induced delay time correction.

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21 4. The method in claim 3, wherein a time difference between the synchronized
22 nodes is in the range of one nanosecond to several microseconds.

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24 5. The method in claim 2, wherein adjacent nodes in the unidirectional optical
25 fiber loop are coupled together by an optical fiber link, further comprising:
26 determining a link time delay associated with one or more of the links, and
27 using one or more determined link time delays in determining one or more time
28 difference between the first node and the one or more other nodes.

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30 6. The method in claim 5, wherein optical time domain reflectometry is used in
31 determining the time delay associated with each link.
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33 7. The method in claim 5, wherein the temperature-induced delay time correction
34 is based on a difference between the first and second round trip delay times and the one or
35 more determined link time delays.
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37 8. The method in claim 5, further comprising:
38 generating a time synchronization message based on the temperature-induced delay
39 time correction, and
40 sending the time synchronization message from the first node to a second of the nodes
41 to permit the second node to adjust the absolute time at the second node to be synchronized
42 with the absolute time at the first node.
43

44 9. The method in claim 5, further comprising:
45 sending a timestamp message from one or more of the other nodes to the first node
46 indicating a local time at that other node, and
47 determining a respective local time difference between the time in each received
48 timestamp message and the local time at the first node.
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50 10. The method in claim 1, wherein the first node is a main base station unit,
51 including processing circuitry and a central clock source, and the one or more other nodes are
52 remote base station units including radio transceiving circuitry for communicating over a radio
53 interface with a mobile radio terminal;

54 wherein the mobile terminal determines one or more a round trip times (RTTs), the
55 RTT corresponding to the time for an RTT message transmitted by the mobile terminal to
56 travel to the remote base station unit and be returned from the remote base station unit to the
57 mobile terminal, and

58 wherein the mobile terminal calculates the one or more RTTs using the measured round
59 trip delay time.
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61 11. The method in claim 10, further comprising:

the mobile terminal sending an RTT message to one of the remote base station units over the radio interface;

the one remote base station unit sending the RTT message to the main base station unit via the unidirectional optical fiber loop;

the main base station unit modifying the RTT message with a recently determined round trip delay time that accounts for temperature induced delay variations in the loop;

the main base station unit sending the modified RTT message to the remote base station unit via the unidirectional optical fiber loop;

the remote base station unit transmitting the modified RTT message to the mobile terminal over the radio interface; and

the mobile terminal determining the RTT based on the modified RTT message.

12. The method in claim 1, wherein one or more links of the unidirectional fiber loop are subjected to temperature variations greater than those to which one or more other portions of the unidirectional fiber loop are subjected.

13. The method in claim 1, further comprising:
calculating a temperature-induced delay time correction for one or more of the nodes other than the first node.

14. Apparatus for use in monitoring transmissions over a unidirectional optical fiber loop coupling multiple nodes, characterized by electronic circuitry configured to:

measure a round trip delay time for a signal sent from a first node to travel around the unidirectional optical fiber loop and be received at the first node, and

account for temperature induced affects on signal transmissions over the unidirectional optical fiber loop using the measured round trip delay time.

15. The apparatus in claim 14, wherein the electronic circuitry is located in a first one of the nodes associated with a central system clock and is further configured to:

determine a first round trip delay time;

subsequently determine a second round trip delay time;

determine a temperature-induced delay time correction based on the first and second round trip delay times; and

95 determine a time difference between the first node and one or more other nodes coupled
96 to the unidirectional optical fiber loop based on the determined temperature-induced delay time
97 correction.
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99 16. The apparatus in claim 15, wherein the electronic circuitry is further configured
100 to time synchronize the multiple nodes taking into account the determined temperature-induced
101 delay time correction.
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103 17. The apparatus in claim 16, wherein a time difference between the synchronized
104 first and second nodes is in the range of one nanosecond to several microseconds.
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106 18. The apparatus in claim 15, wherein adjacent nodes in the unidirectional optical
107 fiber loop are coupled together by an optical fiber link, further comprising:
108 means for determining a link time delay associated with one or more of the links,
109 wherein the electronic circuitry is further configured to use one or more determined
110 link time delays in determining the time difference between the first node and one or more
111 other nodes.
112

113 19. The apparatus in claim 18, wherein means for determining uses optical time
114 domain reflectometry in determining the time delay associated with each link.
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116 20. The apparatus in claim 18, wherein the temperature-induced delay time
117 correction is based on a difference between the first and second round trip delay times and the
118 one or more determined link time delays.
119

120 21. The apparatus in claim 18, wherein the electronic circuitry is further configured
121 to:

122 generate a time synchronization message based on the temperature-induced delay time
123 correction, and

124 send the time synchronization message from the first node to a second of the nodes to
125 permit the second node to adjust the absolute time at the second node to be synchronized with
126 the absolute time at the first node.
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128 22. The apparatus in claim 18, wherein one or more of the other nodes is configured
129 to send a timestamp message to the first node indicating a local time at that other node, and
130 wherein the electronic circuitry is further configured to:
131 determine a respective local time difference between the time in each received
132 timestamp message and the local time at the first node.

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134 23. A system using the apparatus in claim 14, wherein the first node is a main base
135 station unit and the one or more other nodes are remote base station units including radio
136 transceiving circuitry for communicating over a radio interface with a mobile radio terminal,
137 wherein the mobile terminal is configured to determine one or more a round trip times
138 (RTTs), the RTT corresponding to the time for an RTT message transmitted by the mobile
139 terminal to travel to the remote base station unit and be returned from the remote base station
140 unit to the mobile terminal, and
141 wherein the mobile terminal is configured to calculate one or more RTTs using the
142 determined round trip delay time.

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144 24. A system using the apparatus in claim 23, wherein:
145 the mobile terminal is configured to send an RTT message to one of the remote base
146 station units over the radio interface;
147 the one remote base station unit is configured to send the RTT message to the main
148 base station unit via the unidirectional optical fiber loop;
149 the main base station unit is configured to modify the RTT message with a recently
150 determined round trip delay time that accounts for temperature induced delay variations in the
151 loop;
152 the main base station unit is configured to send the modified RTT message to the
153 remote base station unit via the unidirectional optical fiber loop;
154 the remote base station unit is configured to transmit the modified RTT message to the
155 mobile terminal over the radio interface; and
156 the mobile terminal is configured to determine the RTT based on the modified RTT
157 message.

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159 25. The apparatus in claim 14, wherein one or more links of the unidirectional fiber
160 loop are subjected to temperature variations greater than those to which one or more other
161 portions of the unidirectional fiber loop are subjected.

162 26. The apparatus in claim 14, wherein the electronic circuitry is further configured
163 to calculate a temperature-induced delay time correction for one or more of the nodes other
164 than the first node.
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